

Outdoor IEEE 802.11 Testbed

Outputs

- Propagation induced data channel impairments.
- TCP and UDP testing.
- Signal strength to throughput correlation.
- VoIP parameter measurements — jitter and delay.
- Video over Wi-Fi.
- RF characterization of 802.11 signals.
- Spectral behavior in the 2.4 GHz band.

As prices have fallen, the number of 802.11-based wireless local area networks (WLAN) has significantly increased. This technology represents a significant telecommunication resource and therefore is of interest to ITS and NTIA. In the past year, efforts have been made to investigate the operating parameters of 802.11-based wireless data systems from a number of viewpoints.

The low cost of 802.11 equipment has been accompanied by a concomitant wide variation in capabilities. A secondary aspect of the large number of different systems involved in ITS testing has been the capability to investigate the interoperability between different 802.11 WLAN cards and access points (AP). This work has also pointed out compatibility issues regarding the use of 802.11g WLAN cards in 802.11b systems and vice versa.

Because the wireless channel is more complex than the wired channel, protocols like 802.11b exhibit sophisticated behavior at the physical layer which is not easily discernable to the application. A particular result of this behavior concerns the hidden effects of physical layer impairments upon network performance. A portion of the experiments conducted at ITS are designed to investigate the correlation between

network parameters and radio frequency (RF) channel characteristics. For example, gross signal strength measurements may be poor indicators of achievable network throughput. In addition, retransmissions mandated by error indications at the physical layer may adversely impact jitter and latency parameters. Although this impact is not detrimental to transmission control protocol (TCP) data transmissions, it may prove to be significant for real-time packet-based communications using realtime transport protocol (RTP), i.e., Voice over IP (VoIP). ITS is uniquely qualified to investigate realtime voice services over Wi-Fi networks because of its existing voice quality program.

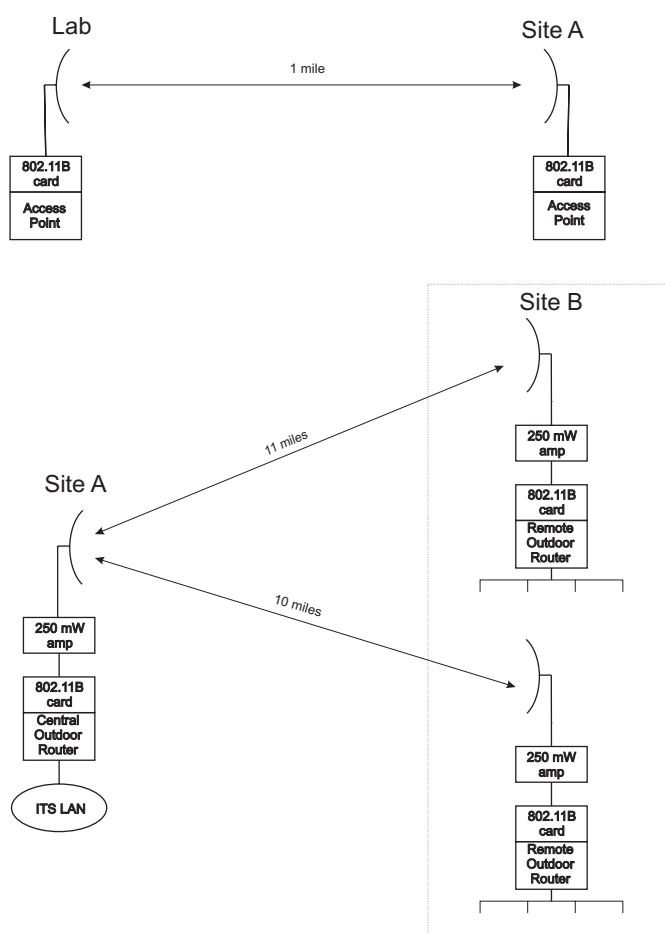


Figure 1. Long range outdoor links between the Green Mountain field site and the Table Mountain field site near Boulder, CO.

Another realtime application that promises to be of increasing interest is packet video over 802.11 networks. Experiments within this realm can take advantage of existing video quality measurement expertise at ITS. These experiments take the form of low frame rate transmissions and thus represent a different measurement regime from the commercial video quality that has been previously studied.

Currently, ITS has set up multiple long range outdoor links, shown in Figure 1 (on previous page) and Figure 2 (below), to explore the impact of environmental factors on communications over 802.11

based carriers. The links consist of 1, 10, and 11 mile distances. This testbed utilizes no proprietary technology but is based on commercial off the shelf equipment. A high gain directional antenna, shown in Figure 3 (below right), is employed at each of the links to provide the required directionality and gain. The experimental installation is capable of providing information about the RF characteristics of the channel as well as multiple packet network parameters. For non-realtime TCP networks, this includes throughput measurements, and for real time transmissions, measurements like delay, jitter and instantaneous packet loss are available.

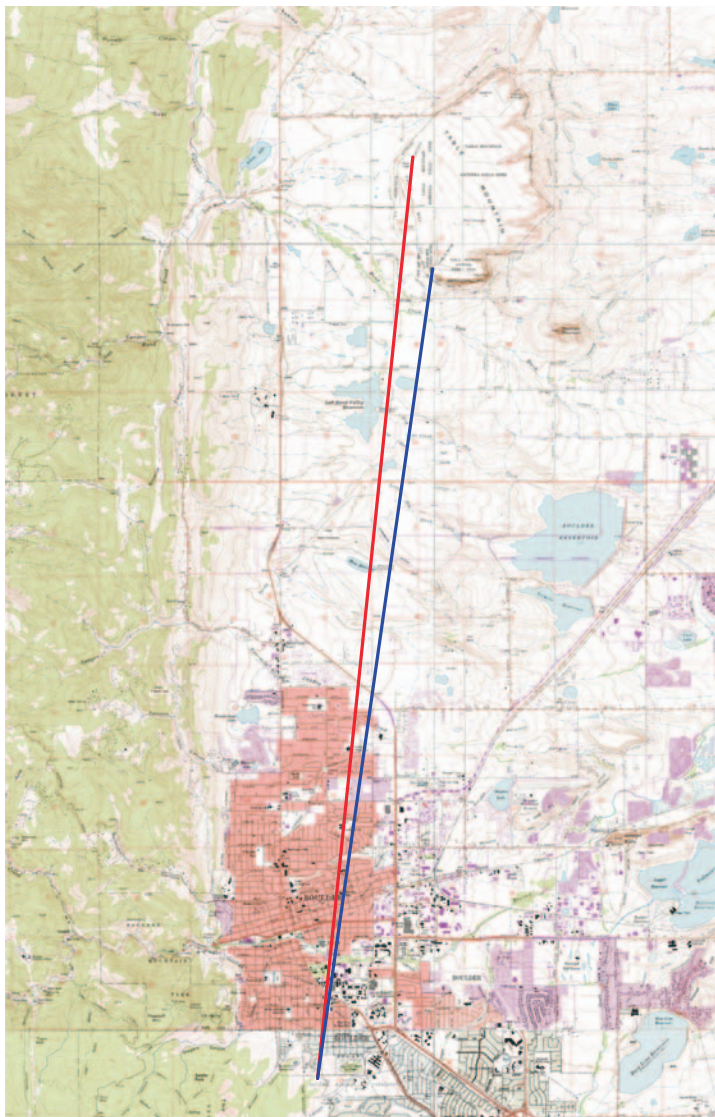


Figure 2. Long range outdoor links between the Green Mountain field site and the Table Mountain field site near Boulder, CO.



Figure 3. High gain directional antenna employed at one outdoor link at the Table Mountain field site (photograph by C. Redding).

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